Influence of Age at Weaning on Caecal Content Characteristics and Post-weaning Performance and Health of Rabbits

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ABSTRACT : This study chiefly aimed to ascertain the effect of age at weaning on caecal content characteristics, post-weaning performance and health of rabbits. A secondary aim was to study the effect of dietary restriction on performance and health of rabbits. After delivery, 30 litters of 8 pups each, were housed in separate cages. Fifteen litters were weaned 24 days from birth (group W 24) while the other 15 were weaned at 28 days (group W28). After weaning, 53 rabbits of group W24 and 56 of group W28 were fed *ad libitum* (group LIB), while 53 rabbits of group W24 and 57 of group W28 were restricted (group RES). All the rabbits were kept in individual cages. Fourteen other rabbits of groups W24 (7 fed *ad libitum* and 7 restricted) and 7 of group W28 were sacrificed to obtain data regarding caecum weight and caecal content. Age at weaning affected neither the state of health nor the final live weight. In comparison with those of group W28, the rabbits weaned at 24 days had a lower daily gain until 35 days of age but gain was higher subsequently. From the 28th day, however, the feed intake and the feed conversion ratio of the group W24 rabbits were always better than those of W28. The restricted diet until 42 days resulted in a lower weight both at 42 days (1,078 vs. 1,164 g) and at 70 days (2,192 vs. 2,294 g). Indeed, from the 42nd day, despite receiving feed *ad libitum* the rabbits of the restricted group continued to ingest less feed (120.8 vs. 127.2 g) than those of the *ad libitum* group, and had a slightly lower daily gain (39.8 vs. 40.3 g). The measurements carried out on the caecum highlighted significant differences among the groups in caecal content (33.1 vs. 31.7 vs. 25.3 g respectively for groups W24LIB, W28 and W24RES), for total volatile fatty acids (53.2 vs. 50.6 vs. 44.5 mmol/l respectively for groups W24LIB, W28 and W24RES) for ammonia (7.0 vs. 7.2vs 8.8 mmol/l respectively for groups W24LIB, W28 and W24RES), for propionate (5.7 vs. 6.3 vs. 8.1% respectively for groups W24LIB, W28 and W24RES) and for propionate/butyrate (0.33 vs. 0.36 vs. 0.49 respectively for groups W24LIB, W28 and W24RES). ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 10 : 1540-1544)***

Key Words : Rabbits, Early Weaning, Performance, Caecal Fermentation, Feed Restricted

INTRODUCTION

Recently, early weaning rabbits has been widely re-proposed (Piattoni and Maertens. 1999; Xiccato et al.. 2000; Gidenne and Fortun-Lamothe. 2001; Trocino et al.. 2001). Early weaning between 21-25 days appears interesting as it reduces the lactation period and may improve the female body condition. Additionally. it may cover the nutritional requirements of young rabbits by using specific starter diets and reduce the incidence of digestive disorders. In this respect, Trocino et al. (2001). comparing pups weaned at different ages (21, 25, 28 and 32 days), observed at 56 days no significant effect of weaning age on growth performance and caecal fermentation traits. without health problems. Similar results have also been obtained by Gidenne and Fortun-Lamothe (2001) in rabbits weaned at 23 and 32 days. In this case, given the same performance during the fattening period, early weaned rabbits registered digestive troubles earlier than controls. Bringing weaning forward to 18-21 days, Piattoni et al. (1999) report that rabbits weaned at 18 days show different growth from those weaned at 32 days. but similar mortality.

Contradictory results were obtained when weaning was carried out at 14 days (ultra-early weaning). Prud'hon and Bel (1968). comparing rabbits weaned at 14 and 32 days. report similar live weight and mortality, while McNitt and Moody (1992) and Ferguson et al. (1997) observed that pups weaned at 14 days have a low feed intake. lower growth and higher mortality than those weaned at 28 days.

The problems that may be encountered at weaning are basically due to the digestive capacity of the young rabbit that reaches peak efficiency only after 6 weeks of life. Moreover. following weaning. rabbits may undergo a dietary shock that can lead to feed hyperintake. 3-4 days after weaning, with serious problems for the gastro-enteric apparatus (Piattoni, 1994).

The aim of this research was to study the effects of two weaning ages (24 and 28 days) and two methods of feed administration (*ad libitum* and restricted) on the performance and health of rabbits after weaning.

MATERIAL AND METHODS

After delivery. 30 litters of 8 pups each. obtained from New Zealand White primiparous does. were separated from their mothers by putting them in a closed cage and subjecting them to programmed lactation. Milk yield was

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Table 1. Ingredients and chemical composition of diets (g/kg as feed)

	Creep diet	Fattening diet	Doe diet
Ingredients			
Dehydrated e meal	250	200	180
Beet pulp	180	155	160
Wheat bran	190	140	50
Soybean meal	155	145	190
Wheat	100	220	312
Wheat straw	90	120	75
Soya oil	15	-	10
Minerals and vitamins	20	20	23
Chemical composition			
Crude protein	170	160	177
Neutral detergent fibre	342	355	308
Starch	76	163	198
Crude fat	40	28	35
Acid detergent fibre	52	45	42

measured by weighing the litters before and after suckling. From day 16 until weaning a "creep feed" (Table 1) was distributed *ad libitum* to the young rabbits, while does were fed commercial feed (Table 1). After weaning, rabbits were kept in individual cages in an experimental room with artificial ventilation and a 12 h light-12 h dark schedule and fed until 42 days with the same weaning feed. From weaning, 53 rabbits of group W24 and 56 of group W28 were fed *ad libitum* (group LIB), while 110 others (53 of group W24 and 57 of group W28) were restricted (group RES). After day 42, all rabbits were given *ad libitum* a fattening diet (Table 1). Live weight and feed intake of rabbits were measured at 24, 28, 35, 42 and 70 days of age.

Chemical analysis of diets followed the method of the Association Of Offical Analytical Chemists (1990) for dry matter (DM), ash, ether extract (EE), crude protein (CP) and crude fibre (CF), and Van Soest et al. (1991) for acid detergent fibre (ADF) with a thermostable amylase pre-treatment.

At 28 days, seven rabbits of group W24RES, seven of group W24LIB and seven of group W28 were sacrificed to obtain data regarding caecum weight and caecal content. Caecal contents, after measurement of the pH with pH-meter Orion EA 940, were frozen at -18°C until the analysis of total volatile fatty acids (VFA) (Perkin Elmer 841 Gaschromatograph with column 80/120 Carbopack B-DA/4% Carbowax 20 M-2 m×2 mm id) and ammonia nitrogen concentration (Boehringer UV urea/ammonia kit method). Data were analysed using a GLM procedure (SAS/STAT, 1989). The factorial model included the effects of age at weaning and dietary restriction (without interaction because not significant).

RESULTS AND DISCUSSION

Effect of weaning age

During the experiment no cases of mortality or digestive troubles were observed. The absence of mortality and digestive troubles over the entire trial period, an exceptional occurrence in rabbit breeding, may be at least partly explained by the good environmental conditions (average

Table 2. Influence of age at weaning and two methods of feed administration on the performance of rabbits (means and standard error of mean:sem)

Groups	W28	W24	Restricted	*Ad libitum*	SEM
Rabbits	113	106	109	110	
Weight at 24 d (g)	499.1	493.7	495.4	497.6	4.27
Weight at 28 d (g)	626.0	576.1	595.0	607.1	4.70
Weight at 42 d (g)	1,148.8^{a}	1,093.4^{b}	1,077.9^{B}	1,163.8^{A}	4.19
Weight at 70 d (g)	2,250.6	2,235.2	2,192.0^{B}	2,293.6^{A}	4.61
Daily gain					
From 24 to 28 d (g/d)	31.7^{A}	20.6^{B}	25.0	27.4	1.12
From 28 to 35 d (g/d)	29.1^{A}	23.6^{B}	23.1^{B}	29.6^{A}	1.02
From 35 to 42 d (g/d)	45.6^{B}	50.3^{A}	45.9^{B}	49.9^{A}	1.01
From 42 to 70 d (g/d)	39.3^{b}	40.8^{a}	39.8	40.3	0.91
From 24 to 70 d (g/d)	38.0	37.9	36.9^{b}	39.0^{a}	0.95
Feed intake					
From 24 to 28 d (g/d)	16.8^{B}	30.4^{A}	22.1^{b}	24.7^{a}	1.62
From 28 to 35 d (g/d)	62.7^{A}	46.0^{B}	48.8^{B}	59.9^{A}	1.49
From 35 to 42 d (g/d)	95.0^{A}	85.0^{B}	85.8^{B}	94.2^{A}	1.44
From 42 to 70 d (g/d)	128.8^{A}	118.1^{B}	120.8^{b}	127.2^{a}	1.36
From 24 to 70 d (g/d)	103.9^{A}	94.5^{B}	95.9^{B}	103.0^{A}	1.32
Feed conversion ratio					
From 28 to 35 d (g/d)	2.18^{A}	1.98^{B}	2.12	2.04	0.23
From 35 to 42 d (g/d)	2.13^{A}	1.71^{B}	1.94	1.90	0.25
From 42 to 70 d (g/d)	3.27^{A}	2.89^{B}	3.10	3.16	0.26
From 24 to 70 d (g/d)	2.90^{A}	2.54^{B}	2.74	2.76	0.25

Values within rows with no common superscript letters are significantly different: capital letters for $p<0.01$, lower case letters for $p<0.05$.

Table 3. Characteristics of caecum and caecal content of rabbits sacrificed at day 28 (means and standard error of mean:sem)

Groups	W24LIB	W28	W24RES	SEM
Rabbits (n)	7	7	7	
Live weight (LW, g)	585	638	570	5.34
Caecal content weight (g)	33.1^{A}	31.7^{A}	25.3^{B}	1.32
Caecal content (% LW)	5.66^{a}	4.96^{b}	4.47^{b}	0.45
Empty caecal weight (g)	11.26	12.20	11.10	0.84
Empty caecal (% LW)	1.92	1.91	1.95	0.26
Dry matter caecal content (%)	26.3	25.8	26.1	0.52
pH	6.11	6.14	6.20	0.26
Ammonia	7.0^{B}	7.2^{B}	8.8^{A}	0.66
Total VFA (mmol/l)	53.2^{A}	50.6^{A}	44.5^{B}	1.14
Acetate (%)	75.6	75.1	74.4	1.25
Propionate (%)	5.7^{b}	6.3^{b}	8.1^{a}	0.68
Butyrate (%)	17.5	17.3	16.4	0.82
Propionate/butyrate	0.33^{b}	0.36^{b}	0.49^{a}	0.26

Values within rows with no common superscript letters are significantly different: capital letters for $p<0.01$, lower case letters for $p<0.05$.

temperature of 18°C with ±2°C variations, relative humidity 70%) and sanitary conditions of the rabbit hutch which, prior to use by rabbits, was disinfected and sanitised.

Rabbits of W24 group had a significantly ($p<0.05$) lower weight (1,093.4 g) on day 42 than those of W28 group (1,148.8 g), while the final weight (70 days) was similar for both groups (2,235.2 and 2,250.6 g, respectively for groups W24 and W28). The rabbits of W24 group had a lower daily gain from 24 to 28 days (20.6 vs. 31.7 g) and from 28 to 35 days (23.6 vs. 29.1 g) and higher daily gain from 35 to 42 days (50.3 vs. 45.6 g) and from 42 to 70 days (40.8 vs. 39.3 g) than those of group W28.

The similar final live weight of rabbits weaned at 24 and 28 days in accordance with findings of other studies (Prud'hon and Bel, 1968; Xiccato et al., 2000; Trocino et al., 2001; Gidenne and Fortun-Lamothe, 2001) suggests that age at weaning does not influence this parameter. Indeed, the rabbits weaned at 24 days, compared with those weaned at 28 days, show around weaning a lower daily gain and lower feed intake, probably caused by greater stress from weaning. Nevertheless, they had compensatory growth since their final weight did not differ from group W28.

The feed intake (Table 2), for the 24-28 day period, was higher in the group weaned at 24 days (30.4 g/d) than in the group weaned at 28 days (16.8 g/d) Subsequently, it was the rabbits weaned at 28 days that showed a higher feed intake (62.7 vs. 46.0 g/d from 28 to 35 d; 95.0 vs. 85.0 g/d from 35 to 42 d and 128.8 vs. 118.1 g/d from 42 to 70 d).

When weaning is anticipated, rabbit pups are not ready to ingest sufficient quantities of solid feed. On this point, Piattoni et al. (1999) found that the pups weaned at 18 days remained 1 or 2 days without ingesting solid feed. These findings agree with those of other researches (Scapinello et al., 1999; Nizza et al., 2002) who reported a low intake of solid feed until day 24 of lactation. In general, however, early weaning entails an increase in solid feed intake compared with what occurs in rabbits that still consume milk. In the period between 18 and 30 days of age, i.e. between the beginning of solid feed intake and weaning, diet in terms of quality and quantity affects the whole life of the rabbit. By extending our knowledge of digestive physiology and the real nutritive value of diets for kits and formulate more suitable diets for early weaning, feed intake in early-weaned rabbits, probably, may well be improved.

The feed conversion ratio (Table 2) was significantly ($p<0.01$) better in the rabbits of group W24 than in those of group W28 for all three periods considered (1.979 vs. 2.178 from 28 to 35 days, 1.714 vs. 2.128 from 35 to 42 days, 2.895 vs. 3.275 from 42 to 70 days). Such results may be at least partly explained by the lower live weight at 42 days of age, the greater daily gain from 35 to 70 days and probably by a higher digestive efficiency of the group W24 rabbits. The latter hypothesis was not verified by experiments.

Effect of restricted feed

The rabbits that received restricted feed until day 42 had a lower weight both at day 42 (1,078 g vs. 1,164; $p<0.01$) and at day 70 (2,192 vs. 2,294 g; $p<0.01$). The difference in daily gain between the two groups was significantly different from 28 to 35 days (23.1 vs. 29.6 g/d; $p<0.01$) and from 35 to 42 days (45.9 vs. 49.9 g/d; $p<0.01$).

The rabbits of the restricted group had approximately 18% less intake from 28 to 35 days and about 9% less from 35 to 42 days. Subsequently, from 42 to 70 days, although the above rabbits received *ad libitum* feed, they continued to have a lower feed intake (120.8 vs. 127.2 g/d) than those that from weaning were fed *ad libitum*. In effect, the lower feed intake in the above period on the part of the restricted group compared with those of the *ad libitum* group may be explained by their lower live weight. Indeed, considering the average live weight in the above period (1,635 and 1,729 g respectively), the feed intake as a % of live weight was similar between groups (7.39 and 7.36 respectively for restricted and *ad libitum* groups).

However, the feed conversion ratio showed no significant difference in any period when comparing the restricted and *ad libitum* rabbit groups. This parameter is normally more favourable due to higher digestive efficiency when there is little dietary restriction. However, considerable restriction worsens feed conversion due to the inevitable reduction in growth. Indeed, generally speaking, the higher the daily gain, the lower is the feed conversion. In this respect, the literature (Gidenne, 1995; Muriu et al., 2002) reports feed conversion ratios lower than 3.0 with daily gains greater than 35 grams and higher than 4.0 with daily gains lower than 25 grams. Szendrò et al. (2000) report significantly ($p<0.05$) more favourable feed conversion in rabbits whose diet restriction was between 4 and 8%, in comparison with the control. In our experiment, although the feed restriction was between 9 and 18%, the differences observed on the feed conversion ratio never reached statistical significance.

Caecal fermentation

Table 3 reports the parameters observed in the rabbits sacrificed at day 28. Caecal content weight was lower in group W24RES (25.3 g) and higher in Group W24LIB (33.1 g) and in group W28 (31.7 g). However, the proportion of caecal content to live weight was significantly higher in group W24LIB (5.66%) than in the other two groups. The empty caecum weight and the proportion of empty caecal to live weight did not differ among the groups. In any case, the values agreed with those reported in the literature (Lebas and Laplace, 1972; Candau et al., 1978; Padilha et al., 1995) and may be considered normal. In this respect, Gidenne (1996) reports caecal content values as % of live weight ranging from 2 to 6 for 25-60 day-old rabbits. Moreover, dry matter caecal content and pH showed no significant differences among the groups.

Notable differences were observed in the characteristics of the caecal contents. In particular, group W24RES animals had higher values of ammonia (8.8 vs. 7.2 vs. 7.0 mmol/l, respectively for groups W24RES, W28 and W24LIB), C_3 (8.1, 6.3 and 5.7 mmol/100 ml respectively for groups W24RES, W28 and W24LIB) and the C_3/C_4 ratio (0.49, 0.36 and 0.33 respectively for groups W24RES, W28 and W24LIB), and lower total VFA (44.5, 50.6 and 53.2 mmol/l respectively for groups W24RES, W28 and W24LIB). Nevertheless, the values observed among the groups are close to those reported in the literature (Gidenne et al., 1991; Gidenne, 1995) for adult rabbits and may be the result of well-established caecal fermentation with the use of solid feed.

CONCLUSIONS

The results obtained in this survey indicate that the early weaning at 24 days of age is possible in that it is not detrimental to the health status either during weaning or post-weaning. Moreover, animals weaned at 24 days, despite experiencing less growth in the first period of post-weaning, reach the same final live weight and have a better feed conversion ratio than those weaned at 28 days. However, restricted feeding applied in the post-weaning period not only fails to improve the state of health of the animals, but results in lower final live weights.

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